Cost-effectiveness of prevention:
Community-based interventions to control and prevent Lyme disease

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What is . . .

The cost-effectiveness of community-based Lyme disease control measures?

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ANSWER:

- **Not sure**
  - **No readily accessible published studies.**

- **WHY no available answer?**
  - **Missing/ non-existent data**

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What is cost-effectiveness?

- Expressed as $/ per unit health outcome
  - E.g., $/ case averted

- Cost per case = $\frac{\text{\$ Intervention - \$ saved}}{\text{Cases averted}}$

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REMEMEBR

Cost-Effectiveness ≠ Cost Savings

What is:

a ”reasonable” threshold?

the maximum “allowable” $/ case averted?

“Cost-Effectiveness” is SUBJECTIVE term

FURTHER

Cost Savings ≠ "Must Do"

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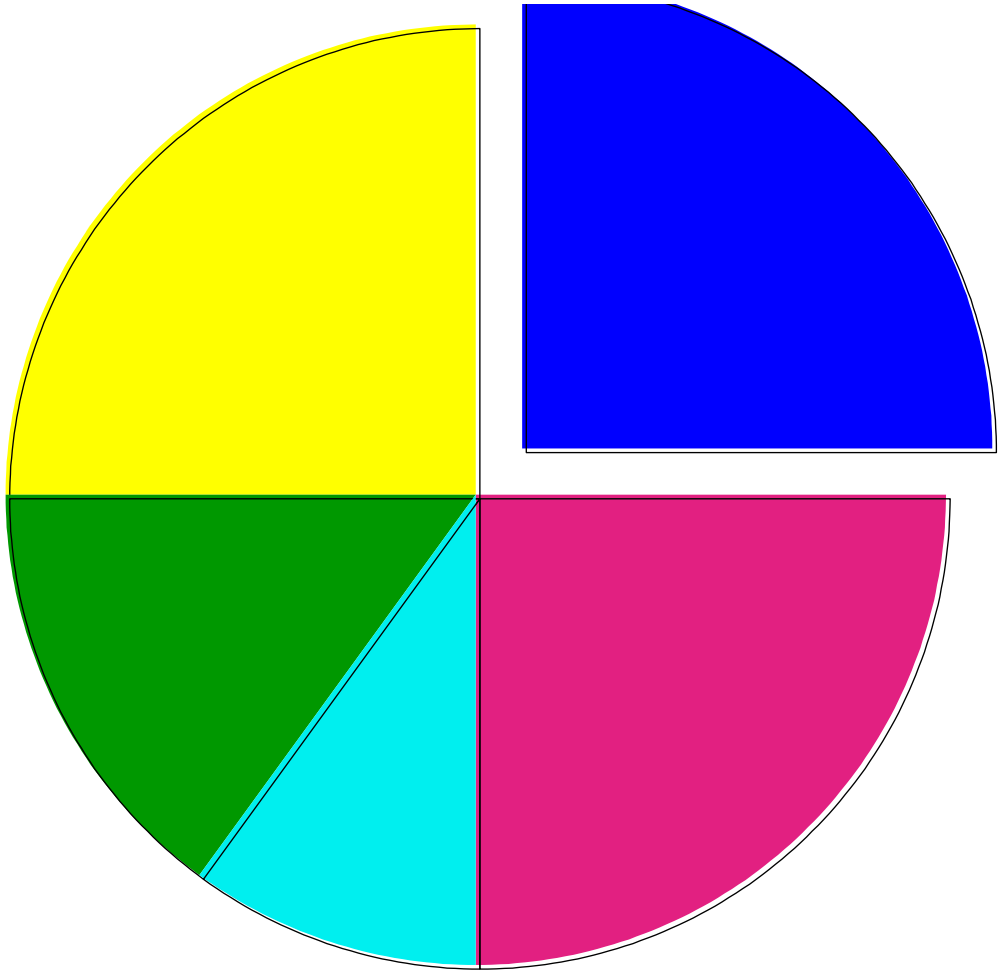
Economics: Part of the "Decision pie"



4 data "buckets" needed for a good cost-effectiveness study

- Epidemiology and clinical
  - Who, when where, what happens
- Cost of clinical illnesses and outcomes
- Interventions
  - What, how well work, where, side effects?
  - Must have a comparator
- Cost of interventions
  - Must include $ of treating side effects

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Epidemiological data: Risk clinical case
Confirmed cases / 100,000 population

State	2007	2008	2009
Alabama	0.3	0.1	0.1
Alaska	1.5	0.9	1.0
Arizona	0.0	0.0	0.0
Arkansas	0.0	0.0	0.0
California	0.2	0.2	0.3
Colorado	0.0	0.0	0.0
Connecticut	87.3	78.2	78.2
Delaware	82.7	88.4	111.2
District of Columbia	19.7	12.0	8.8
Florida	0.2	0.4	0.4
Michigan	0.5	0.8	0.8

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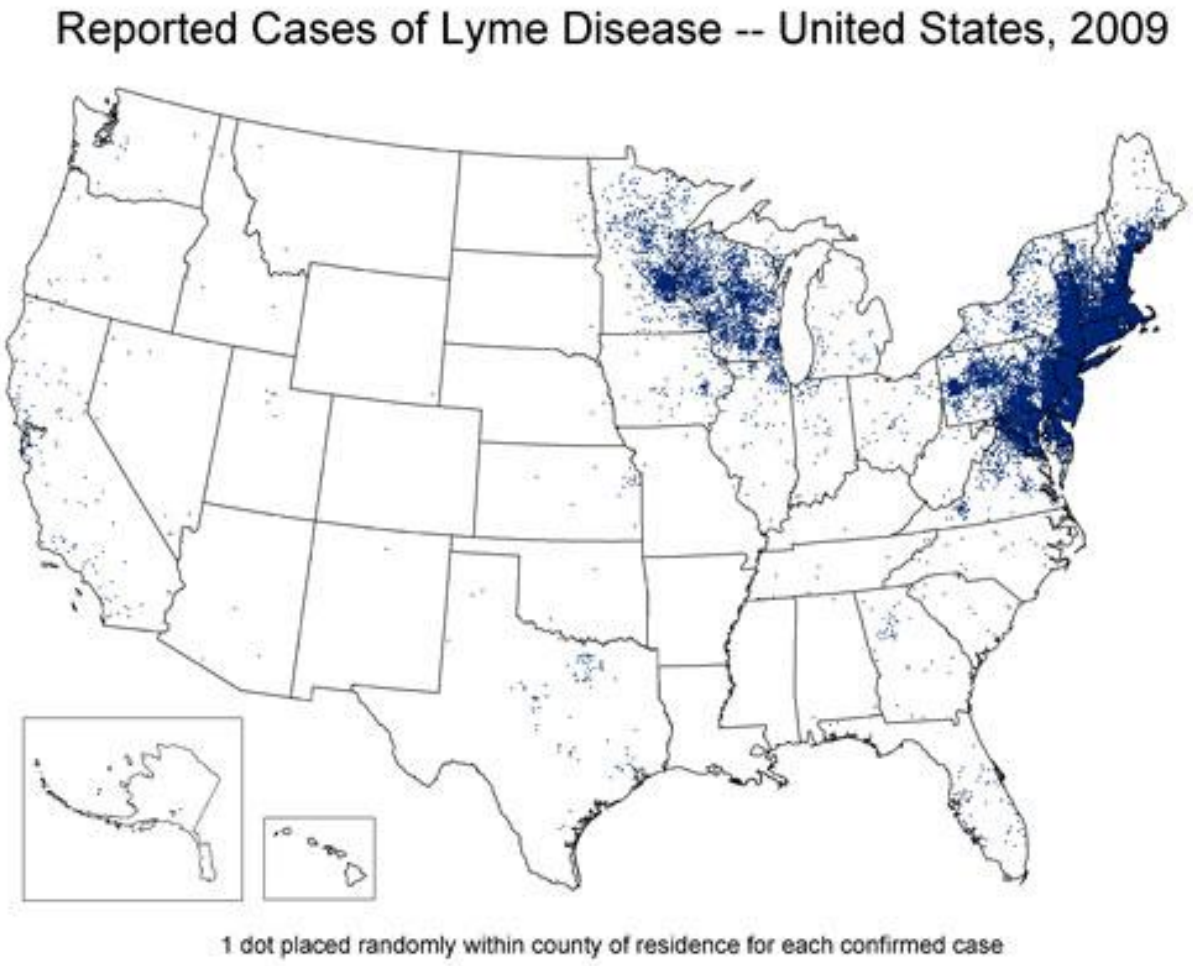
Source: http://www.cdc.gov/ncidod/dvbid/lyme/ld_IncidenceRatesbyState20052009.htm

Epidemiological data: Risk clinical case



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Source: http://www.cdc.gov/ncidod/dvbid/lyme/ld_Incidence.htm

Epidemiological data

EPIDEMIOLOGY AND DETERMINANTS

GARY SMITH, DPHIL ■ E. PAUL WILEYTO, PHD MS
ROBERT B. HOPKINS ■ BRYAN R. CHERRY, VMD
JOHN P. MAHER, MD MPH

Risk Factors for Lyme Disease in Chester County, Pennsylvania

Smith et al. Public Hlth Report 2001 (supp 1).

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Epidemiological data

- Risk factors:
  - Age: 10-19 years; and 50+ years of age
  - Rural > urban (3 times more)
  - Single homes, homes with woods, <100 ft to woods
  - Gardening + 4 hrs/ week

  - Other factors: not risk

Source: Smith et al. Public Hlth Report 2001 (supp 1).

- MUST place risk in context
  - Geography, season, exact activity, ecology, etc.

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Reported Lyme Disease Cases by Age Category, United States, 1992-2006

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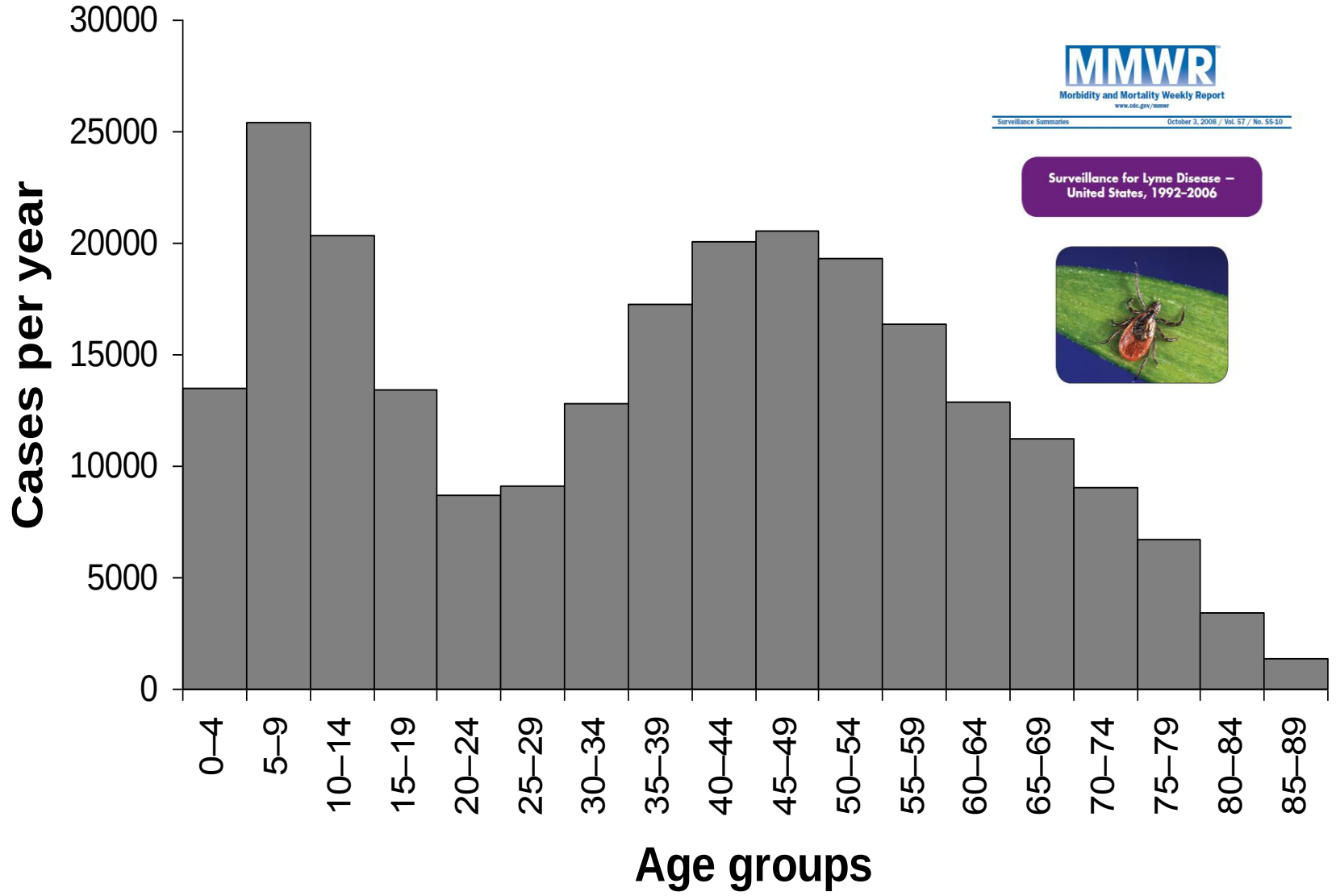
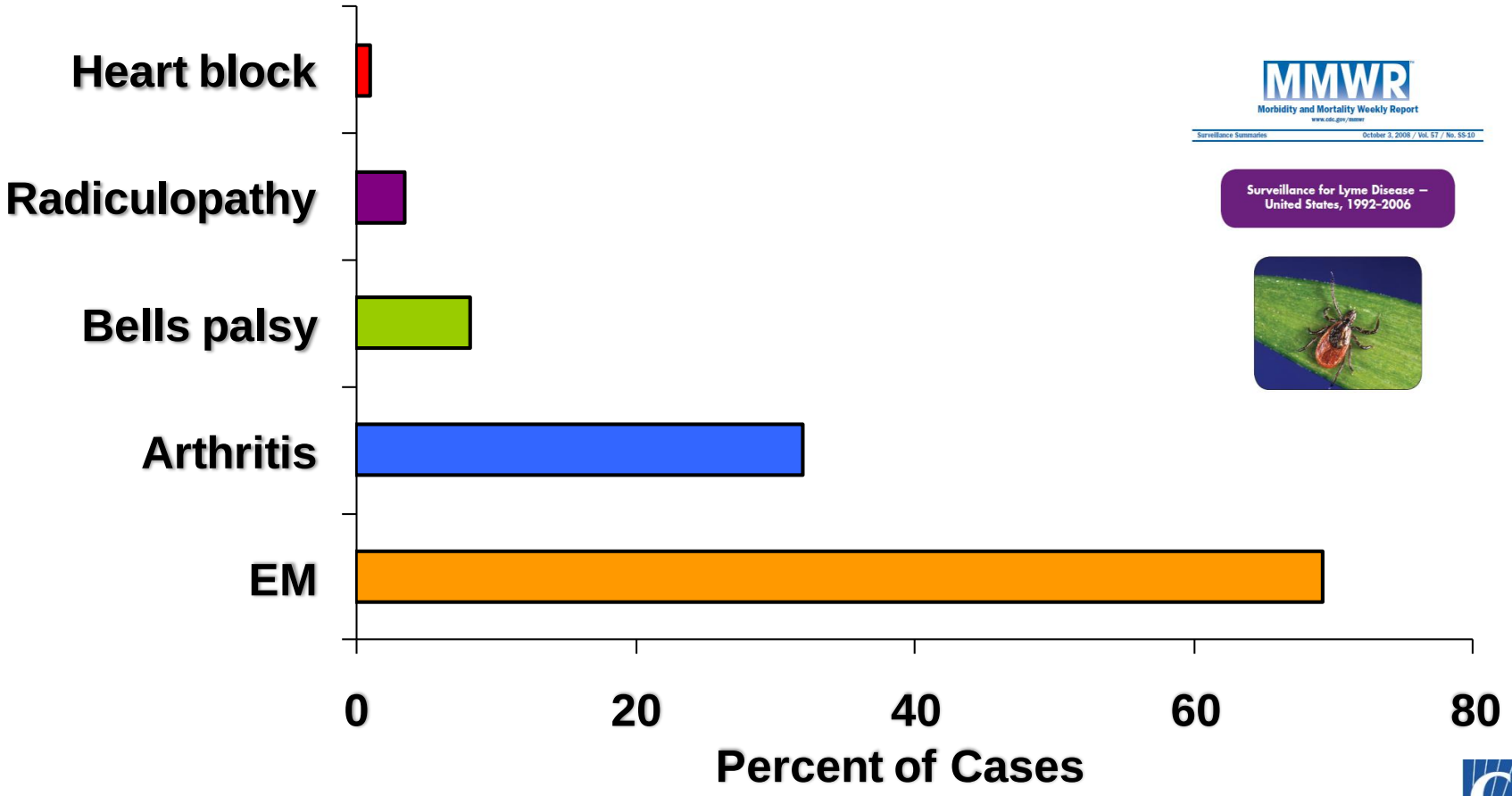


Clinical Features of Lyme Disease Cases Reported to CDC, United States, 1992-2006



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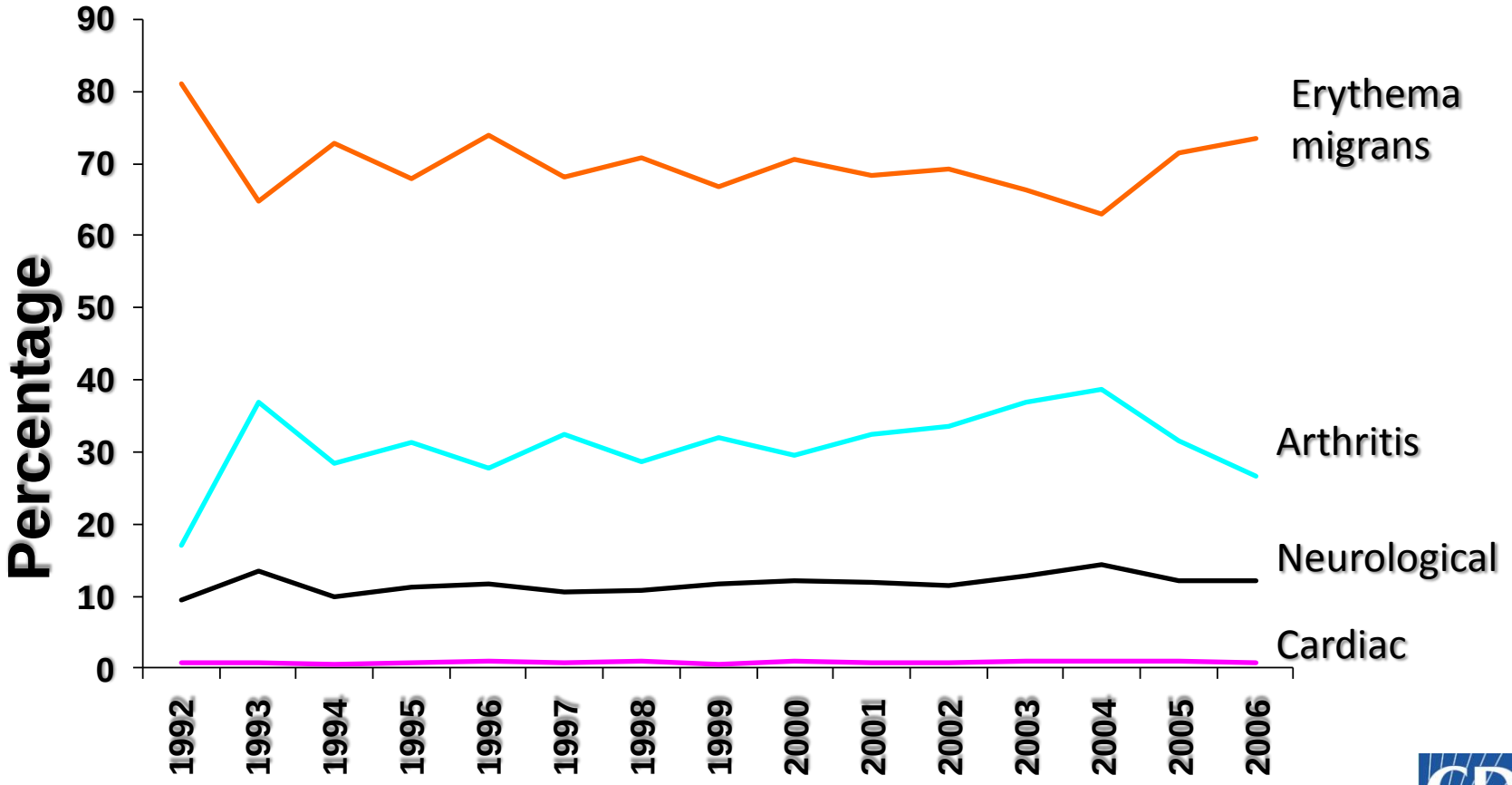
Change in Frequency of Clinical Features, United States, 1992-2006

MMWR
Morbidity and Mortality Weekly Report

Surveillance for Lyme Disease – United States, 1992–2006



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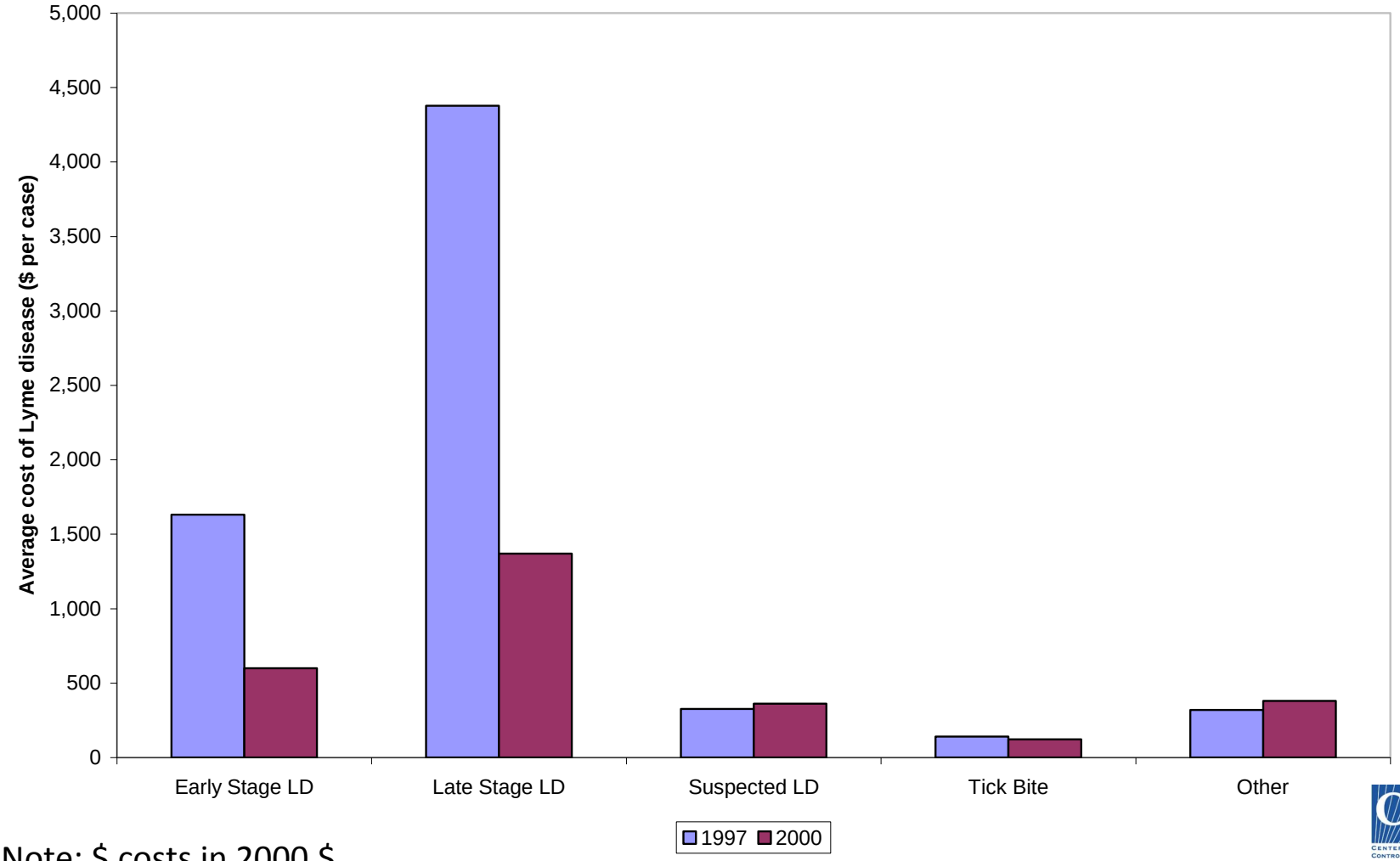
Bucket #2: Cost of case

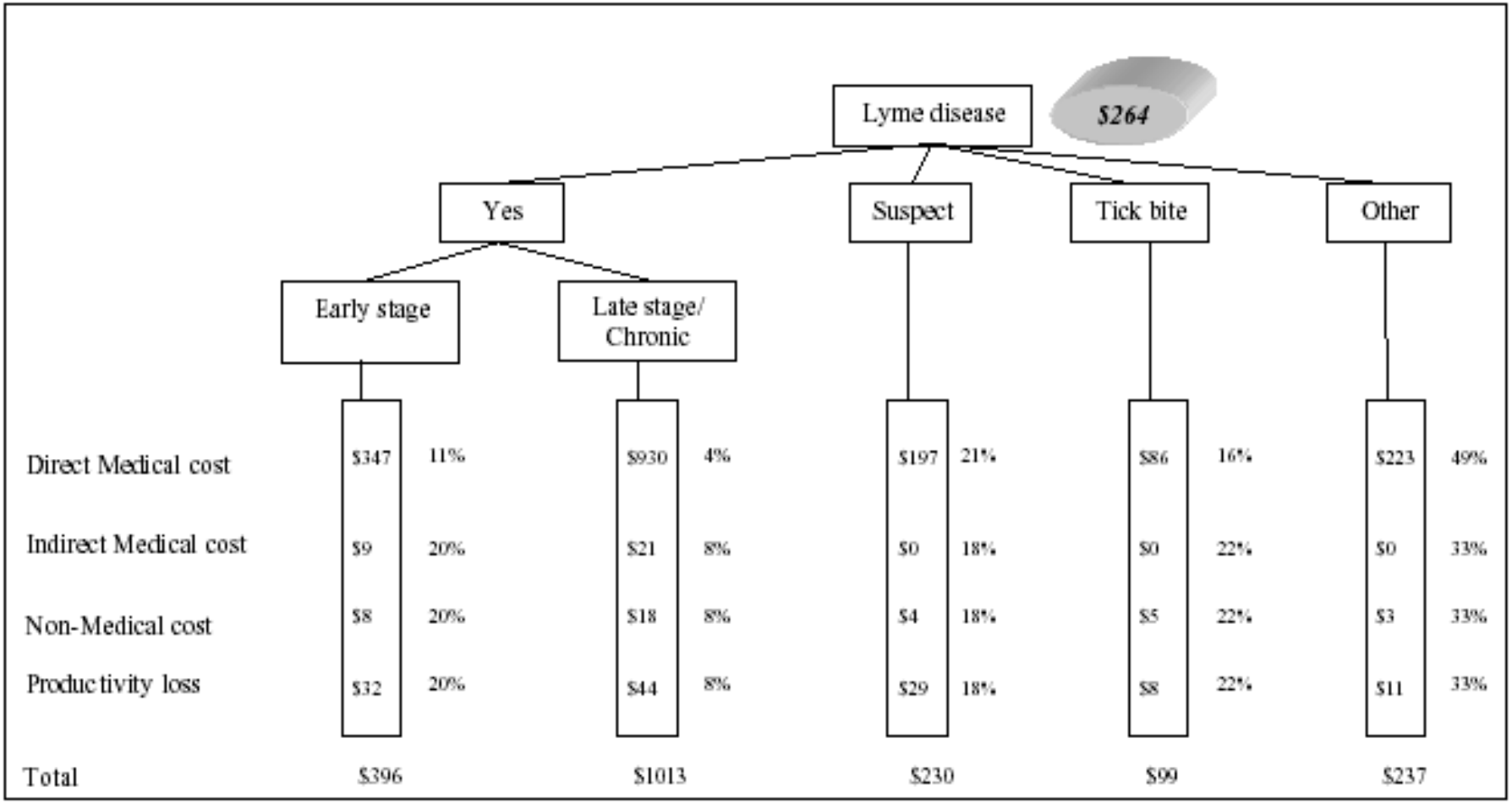
Figure 2. Trend of direct medical cost of Lyme disease 1997-2000



Note: $ costs in 2000 $

Source: Zhang et al. Emerg Infect Dis 2006

Bucket #2: Cost of case: outcome tree



Note: $ costs in 2000 $

Source: Zhang et al. Emerg Infect Dis 2006

Bucket #2: Cost of confirmed case

- For each confirmed LD patient
  - $2,970 direct medical cost
  - $4,762 indirect medical cost, non-medical cost and productivity loss
- Economic burden of LD in U.S. (2000 $)
  - 184 million dollars
  - Conservative and underestimated

Note: $ costs in 2000 $
Source: Zhang et al. Emerg Infect Dis 2006

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Bucket #3: Interventions

- Vaccination
- Control tick hosts
  - Population reduction or exclusion
- Personal protection
- Control ticks
  - On hosts or on ground

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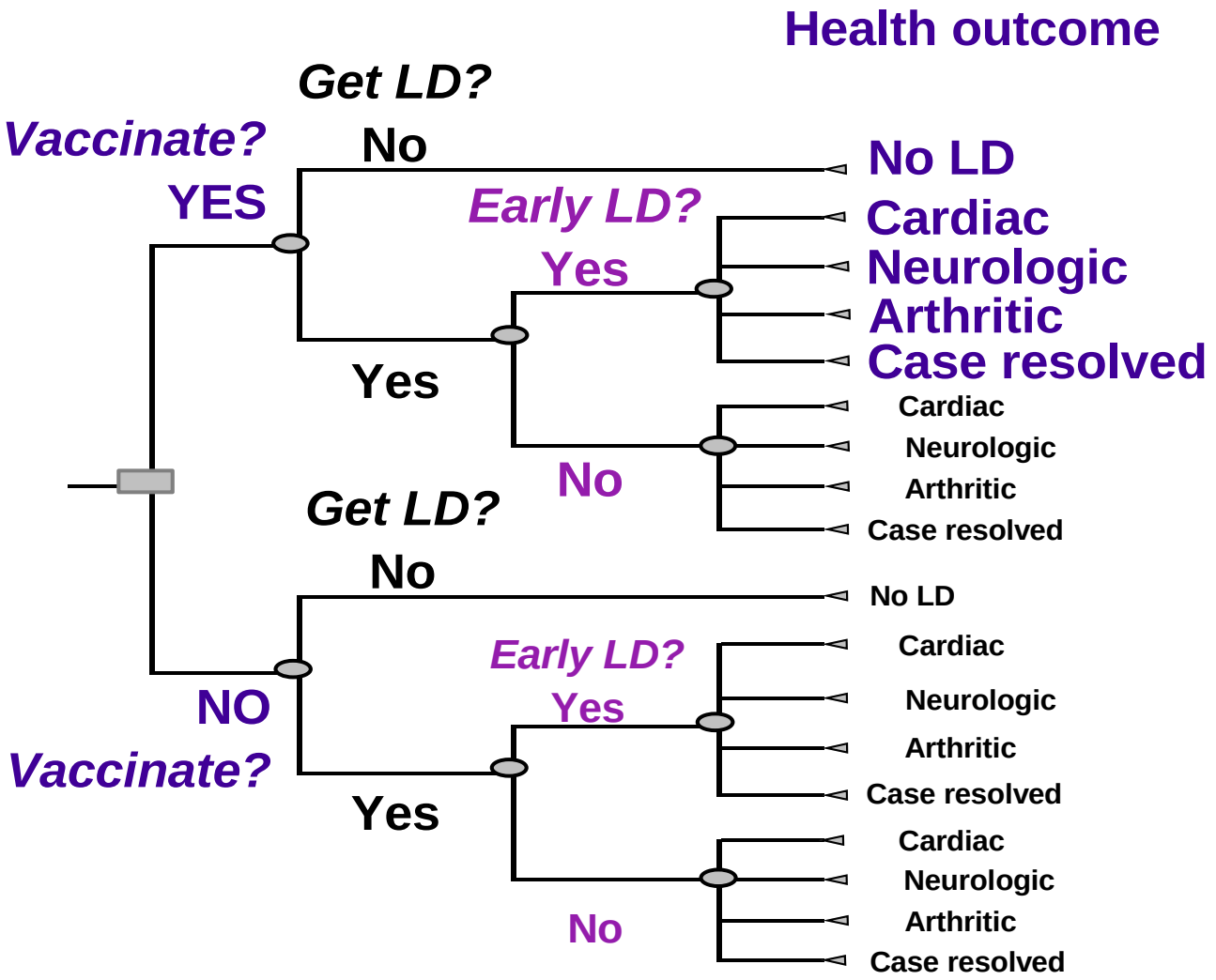
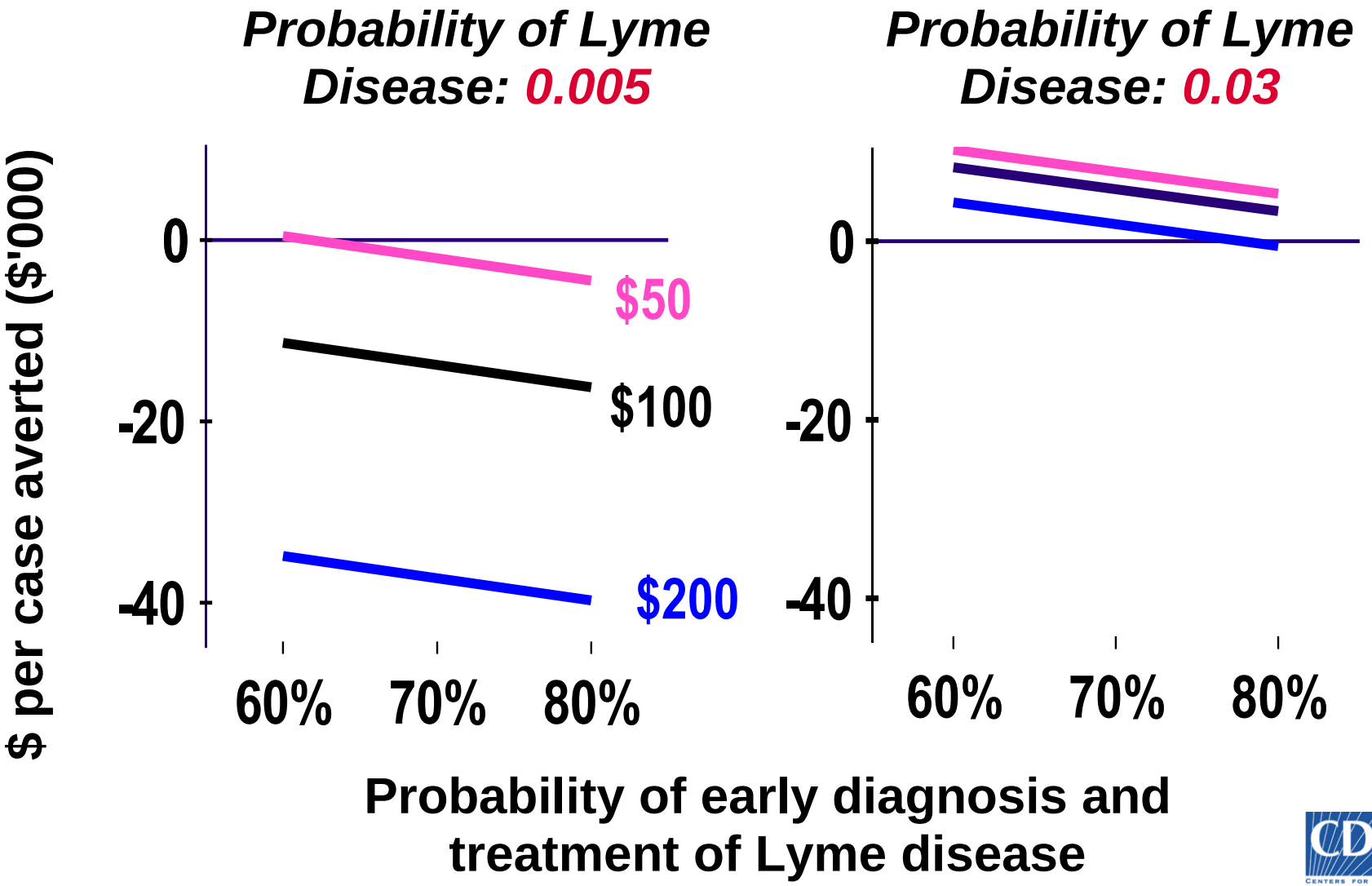
Interventions: vaccine: analysis



Source: Meltzer et al. Emerg infect Dis 1999

Results: Cost effectiveness



Source: Meltzer et al. Emerg infect Dis 1999

Conclusions: Vaccine: Cost -effectiveness

- **Public health policy implications**
  - **Value in targeting by risk of LD**
  - **Value in increasing probability of correct eraly diagnosis and successful treatment**

- **Similar conclusions from:**
  - **Hsia et al. Arthritis & Rheumatism, 2002.**

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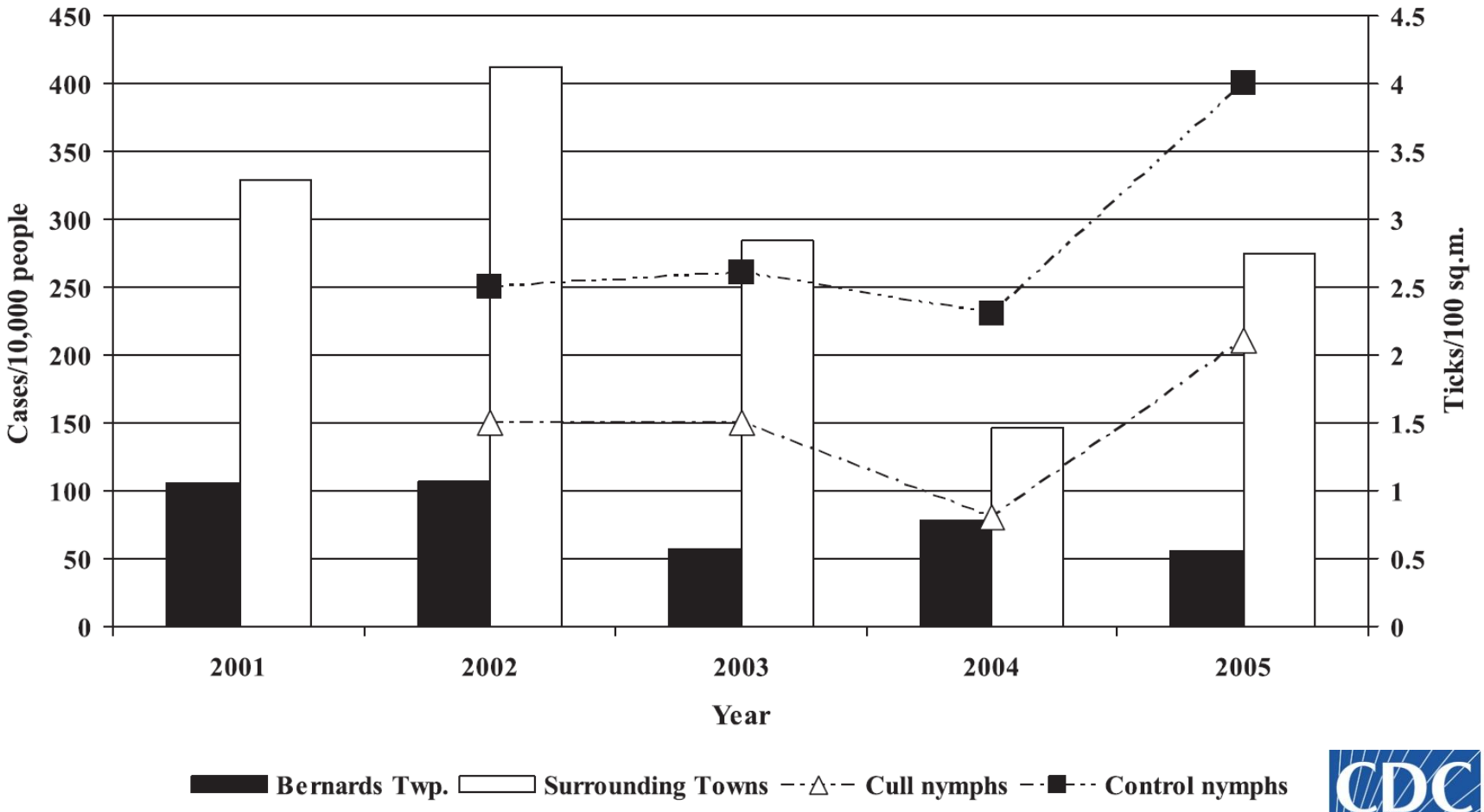
Interventions: Control hosts

White footed mouse

White tailed deer

Natural hosts and reservoirs of *B. burgdoferi*

Deer Reduction: NJ



Source: Jordan et al, J. Med Entomol, 2007

Personal protection: reduced risk: CT:

- **Protective clothing: 40% (95% C.I.: 30 – 50%)**
- **Tick repellants: 20% (10% - 40%)**
- **Checking for ticks: 0% Not effective**
- **Spraying property: 0% Not effective**

Note: case control: CT. 709 cases
Source: Vazquez et al Emerg Infect Dis 2008

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Personal protection: In-yard

- **Bathed within 2 hrs: 40% (95% C.I.: 22% – 77%)**
- **Tick repellants: 41% (N/A - 65%)**
- **Checking for ticks: 45% (6% - 68%)**
- **Fencing yard : 46% (10% – 66%)**
- **All else (spraying, landscape, etc.): No effect**

Note: Case control: CT.: 364 cases enrolled
Source: Connally et al. Am J Prevent Med 2009

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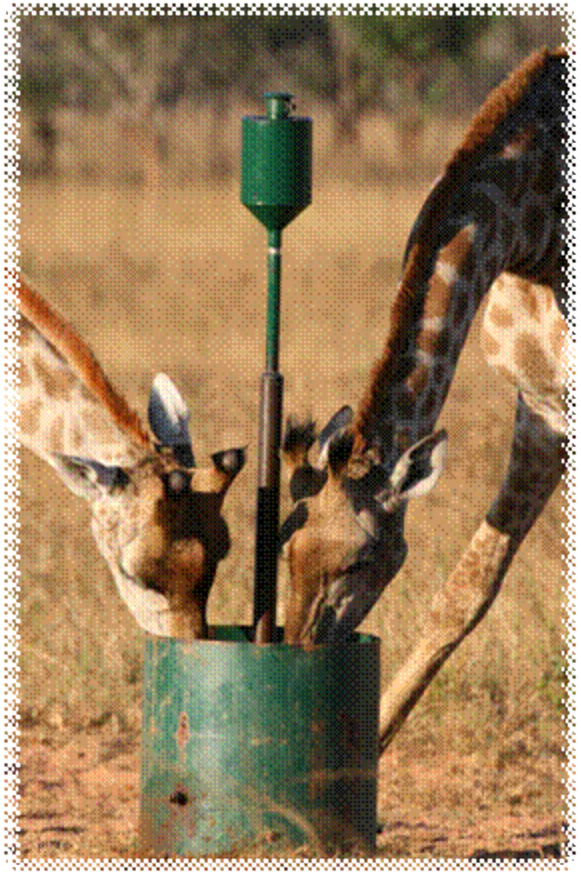
Self-Medicating applicators: History: Duncan Applicators – 1970s onward



Source: http://www.wpazambia.com/ForSaleSpecialOffers/DuncanApplicator.html

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Self-medicating applicators

US005357902A

United States Patent [19]

Norval et al.

[11] **Patent Number: 5,357,902**

[45] **Date of Patent: Oct. 25, 1994**

[54] **SELF-MEDICATING APPLICATOR FOR CONTROLLING PESTS ON ANIMALS**

[75] Inventors: **R. Andrew Norval; Martin I. Meltzer,** both of Gainesville, Fla.; **Daniel E. Sonenshine,** Virginia Beach, Va.; **Michael J. Burridge,** Gainesville, Fla.

[73] Assignees: **Old Dominion University,** Norfolk, Va.; **University of Florida,** Gainesville, Fla.

[21] Appl. No.: **102,599**

[22] Filed: **Aug. 5, 1993**

[51] **Int. Cl.**[5] **A01K 29/00**
[52] **U.S. Cl.** **119/157**
[58] **Field of Search** 119/156, 157, 158

[56] **References Cited**

U.S. PATENT DOCUMENTS

680,807 8/1901 Pendleton 119/157
988,669 4/1911 Shuler 119/157

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8800079 7/1989 South Africa .

OTHER PUBLICATIONS

Drummond, R. O. et al. (1988) "Effects of Arthropod Pests on Livestock Production" Control of Anthropod Pests of Livestock pp. 1–27.

Sutherst, R. W. et al. (1982) "Tropical legumes of the genus *Stylosanthes* immobilize and kill cattle ticks" Nature 295:320–321.

McCosker, P. J. (1979) "Global Aspects of the Management and Control of Ticks of Veterinary Importance" Recent Advances in Acarology 2:45–53.

Norval, R. A. I. (1990) "The Impact of Pure Infestations of *Rhipicephalus appendiculatus* and *Amblyomma hebraeum* on the Productivity of Cattle and Implications for Tick Control Strategies in Africa" Parassitologia 32:155–163.

Primary Examiner—Gene Mancene
Assistant Examiner—Thomas Price
Attorney, Agent, or Firm—Saliwanchik & Saliwanchik

[57] **ABSTRACT**

The device is a self-medicating applicator that can be

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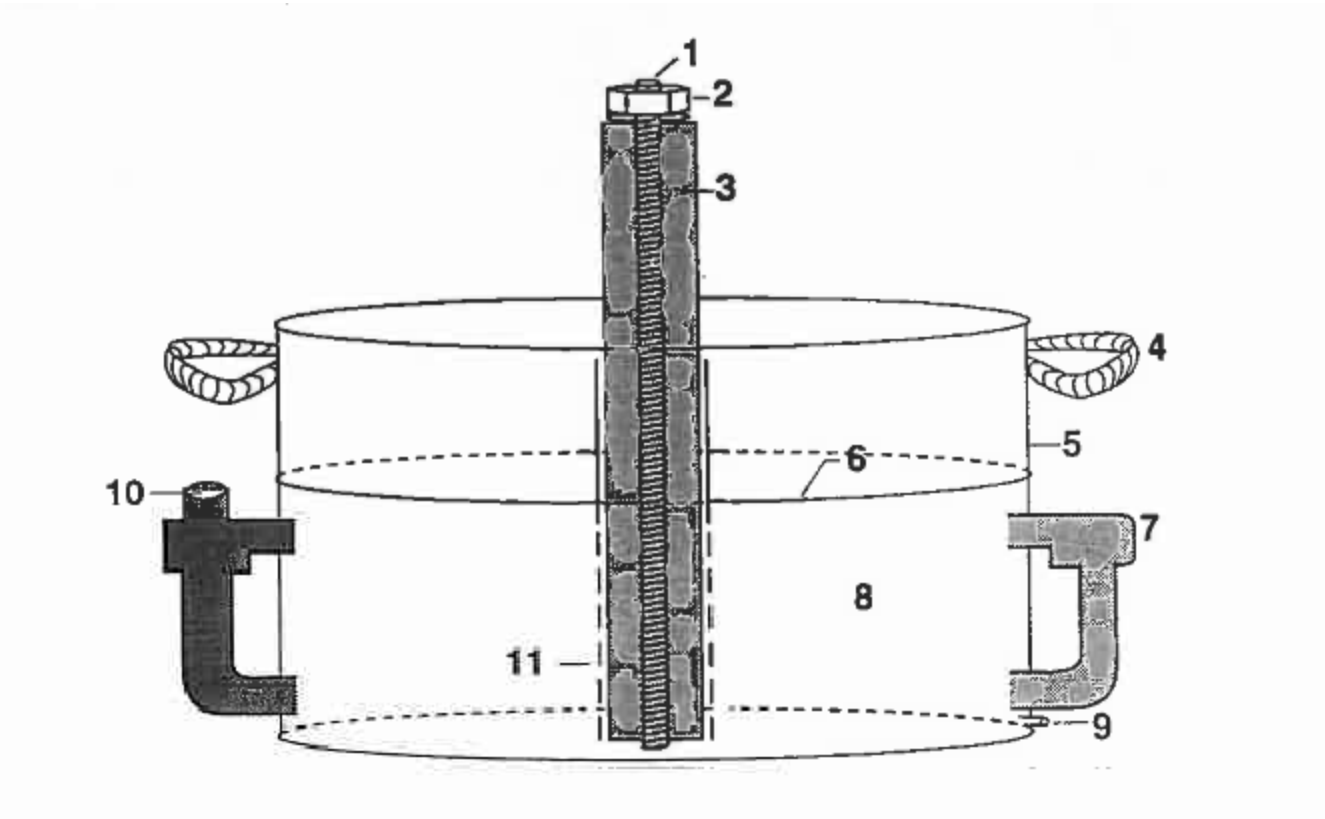
Self-medicating applicators



Source; Norval et. al: Self medicating applicator for controlling pests on animals. U.S. Patent 5,357,902, Oct 25, 1994.

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Impact of applicators: White-tailed deer

Group	Ticks* / deer	S.E.
Treatment: pesticide	3.4	1.1
Control: mineral oil	10.8**	3.0

*Ticks: Ixodes scapularis

** $P < 0.0001$

Source: Sonenshine et al Med Vet Entom 1996:10:1490154

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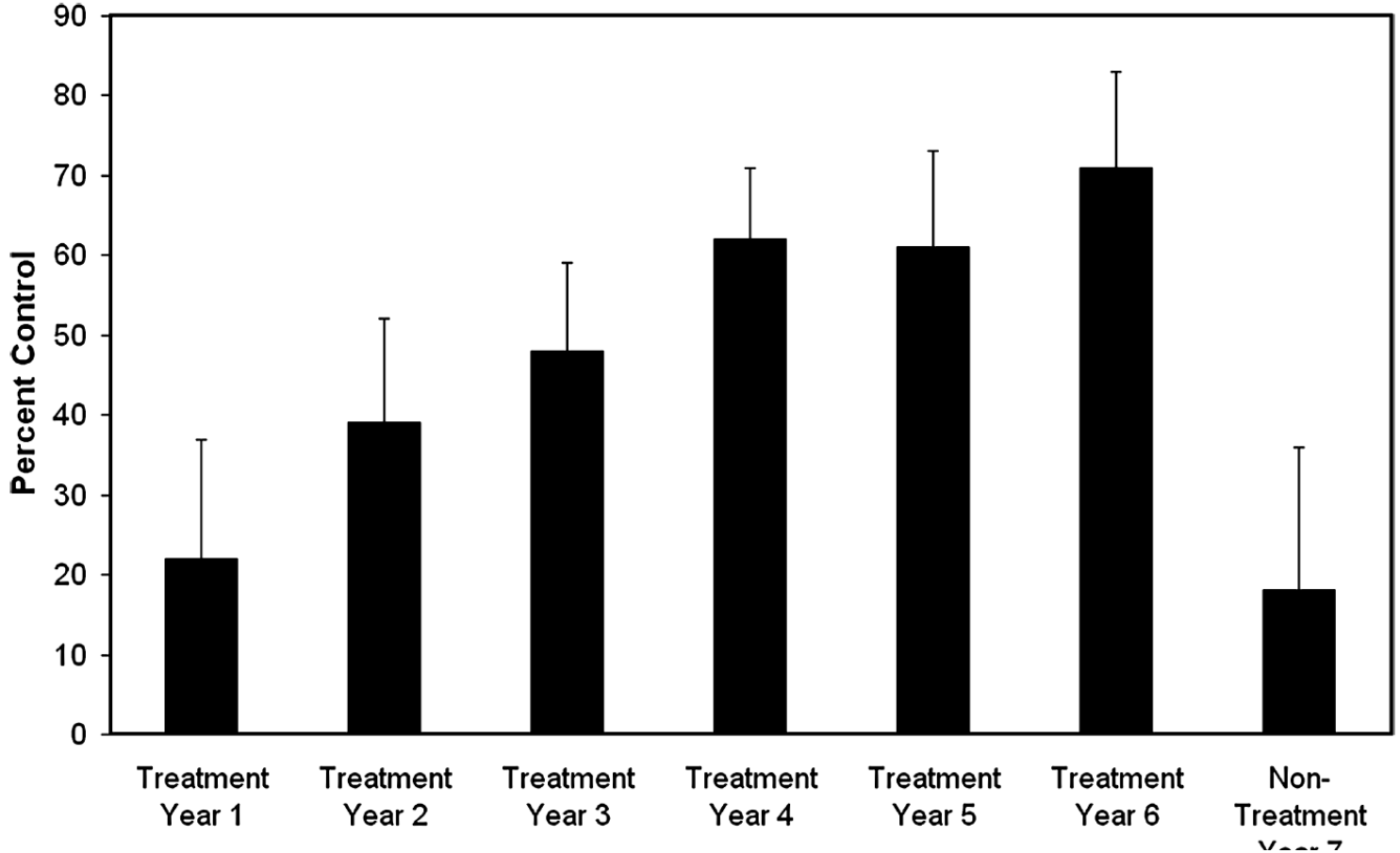
Impact of applicators: Nymphs: 5 sites



Source: Brei et al. Vect Borne Zoo Dis, 2009

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Potential problem: Alternative hosts

- **Mice not primary host for ticks nor primary reservoir for *B. burgdorferi ss*,**
- **Mice feed 10% all ticks ; 25% *B. burgdorferi*-infected ticks**
- **Inconspicuous shrews feed 35% all ticks; 55% infected ticks**
- **May require interventions for multiple species**

Source: Dustin et al. Proc R Soc B, 2008

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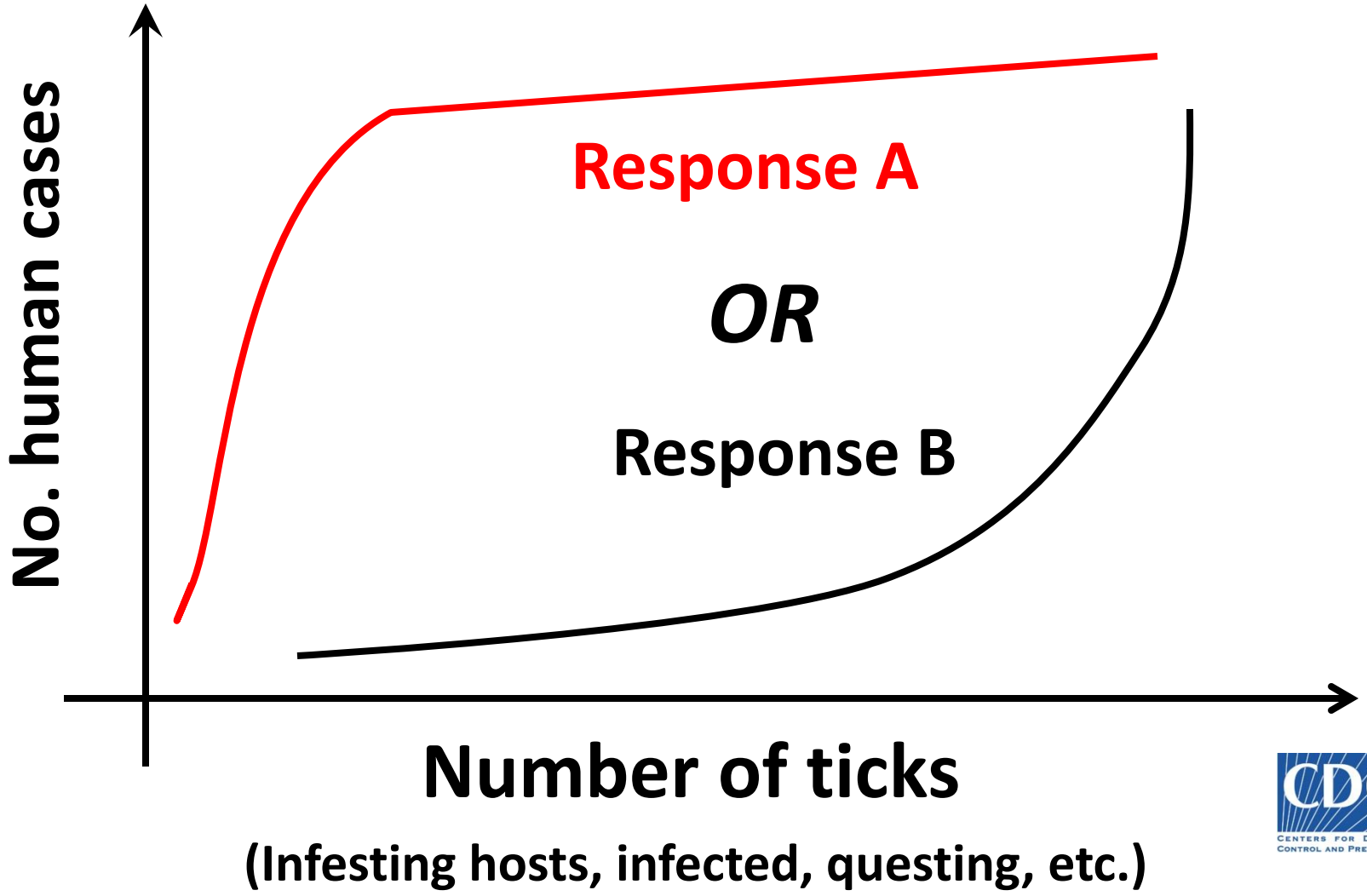
Applicators: What is missing?



In other words: Don't need this . . .

Ixodes scapularis

Source: CDC Public Health Image Library http://phil.cdc.gov/phil/home.asp

Need this: Impact on risk of cases

Source: CDC Public Health Image Library http://phil.cdc.gov/phil/home.asp

Bucket #4: $ of interventions

- $ vaccination - have/ had
- $ costs of other interventions
  - Appears to be mostly lacking

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Bucket #4: Stated support

	Westport Weston, n (%)	
	2002	*2004*
Reduced deer population	261 (71)	290 (78)[a]
Provide information	394 (99)	386 (98)
Use pesticides on deer	288 (80)	258 (74)[a]
Use pesticides	239 (68)	256 (70)

[a] $p < 0.05$; [b] $p < 0.01$.

Source: Gould et al, Vect Borne Zoo Dis, 2008

Bucket #4: Beware

- What people say and what they do
  - Often 2 very separate things
- Support of community intervention
  - Depends upon perceptions
  - Can you “see” cases?
- Compliance over time
  - Incredibly big issue
  - “poorly” measured – if at all.

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Conclusions: Cost-effectiveness of community based interventions

- Lack adequate data
  - Relationship: tick reduction and cases
  - Effectiveness over time
    - Compliance over time – usually drops
  - Costs of interventions
    - Sustained – can't stop
  - Costs of side effects of interventions

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Conclusions: Cost-effectiveness of community based interventions

- **What is needed:**
  - **Field trial(s)**
    - **Large**
    - **Measure impact on cases**
    - **Run for "some time"**
      - **E.g., 3 – 5 years**
    - **Measure changes in community acceptance**
    - **More than 1 site**
    - **Measure – different risks, attitudes, etc.**

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